Journal of Adolescence 89 (2021) 149–160

Contents lists available at ScienceDirect

Journal of Adolescence

journal homepage: www.elsevier.com/locate/adolescence

Executive function as a mechanism linking socioeconomic status to internalizing and externalizing psychopathology in children and adolescents

Elizabeth A. McNeilly [a, *], Matthew Peverill [b], Jiwon Jung [c], Katie A. McLaughlin [d]

[a] Department of Psychology, University of Oregon, USA
[b] Department of Psychology, University of Washington, USA
[c] Department of Psychiatry and Biobehavioral Sciences and the Semel Institute for Neuroscience and Human Behavior, University of California, Los Angeles, USA
[d] Department of Psychology, Harvard University, USA

ARTICLE INFO

Keywords:
Child/adolescent
Socioeconomic status
Executive function
Internalizing disorders
Externalizing disorders

ABSTRACT

Introduction: The association between low socioeconomic status (SES) in childhood and increased risk for psychopathology is well established, but the mechanisms explaining this relationship are poorly understood. Here, we investigate the potential role of difficulties in executive functioning (EF) as a mechanism linking childhood and adolescent SES with externalizing and internalizing psychopathology.

Methods: We examined whether difficulties with EF mediated the association between SES and externalizing and internalizing psychopathology in two cross-sectional samples of children and adolescents (Study 1: N = 94, ages 6–18, 51.1% male; Study 2: N = 259, ages 8–16, 54.1% male) from diverse SES backgrounds in the United States. EF was measured through behavioral tasks and parent-reported behavioral regulation (BR).

Results: In both samples, children and adolescents from lower SES families were more likely to experience both externalizing and internalizing psychopathology than youth from more advantaged backgrounds and exhibited greater EF difficulties – they had lower performance on a task measuring inhibitory control and lower parent-rated BR. Reduced inhibitory control and BR, in turn, were associated with higher externalizing and internalizing psychopathology. In Study 1, difficulties with BR mediated the association of low-SES with both externalizing and internalizing psychopathology. In Study 2, low inhibitory control mediated the association between low-SES and externalizing psychopathology. These findings largely persisted after adjusting for exposure to violence, a form of adversity that is common in children from low-SES backgrounds.

Conclusions: These findings suggest that reduced EF may be an underlying mechanism through which low-SES confers risk for psychopathology in children and adolescents.

One in six children under the age of 18 in the United States live in poverty (Semega, Kollar, Creamer, & Mohanty, 2019). Low socioeconomic status (SES) in childhood has been associated with atypical cognitive development, particularly in the domains of executive functioning and language (Duncan, Brooks-Gunn, & Klebanov, 1994; Farah et al., 2006; Noble, Farah, & McCandliss, 2006).

* Corresponding author. 1227 University of Oregon, Eugene, OR, 97403, USA.
E-mail address: emcneill@uoregon.edu (E.A. McNeilly).

https://doi.org/10.1016/j.adolescence.2021.04.010
Received 7 July 2020; Received in revised form 19 April 2021; Accepted 26 April 2021
Available online 7 May 2021

These differences may contribute to well-documented disparities in academic achievement (Bradley & Corwyn, 2002; Brooks-Gunn & Duncan, 1997; Miller, Votruba-Drzal, & Setodji, 2013; Rosen, Sheridan, Sambrook, Meltzoff, & McLaughlin, 2018) and increase risk for developing certain forms of psychopathology (Hatoum, Rhee, Corley, Hewitt, & Friedman, 2017; McLoyd, 1998). Both externalizing and internalizing psychopathology are more common among children from low-SES households (Capistrano, Bianco, & Kim, 2016; McLaughlin, Costello, Leblanc, Sampson, & Kessler, 2012; Peverill et al., 2020). Here, we examine whether executive functions (EF)—including inhibition, cognitive flexibility, and behavioral regulation (BR)—are a potential mechanism explaining the association between SES and child psychopathology, including symptoms and features of a range of mental disorders reflecting the higher order dimensions of internalizing and externalizing.

SES-related differences in child psychopathology have been consistently documented across multiple domains of measurement including family income, parent education, and food insecurity (Brooks-Gunn & Duncan, 1997; McLaughlin, Green, et al., 2012; Peverill et al., 2020; Shankar, Chung, & Frank, 2017). EF is a potential developmental mechanism, given that it is consistently associated with both SES and psychopathology in children and adolescents (Blair & Raver, 2016; Lawson, Hook, & Farah, 2018; McLaughlin, 2016; Zelazo & Mller, 2002). EF is a set of cognitive skills involved in goal-directed behavior that is critical for adaptive functioning and academic success (Best & Miller, 2010; Blair & Diamond, 2008; Samuels, Tournaki, Blackman, & Zilinski, 2016). These processes include manipulating information in working memory, inhibiting automatic responses, and shifting between mental sets (i.e., cognitive flexibility) (Friedman & Miyake, 2017; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). The ability to engage in BR in daily life is inextricably tied to EF (Miyake & Friedman, 2012; Zhou, Chen, & Main, 2012) as an external manifestation of cognitive EF processes.

Multiple aspects of SES have been associated with EF in children and adolescents. Parent educational attainment is associated with performance on working memory and inhibition tasks (Farah et al., 2006; Noble, Norman, & Farah, 2005; Sheridan et al., 2017). Family income is associated with working memory, inhibition, cognitive flexibility, and BR (Evans & Rosenbaum, 2008; Noble et al., 2005; Raver, Blair, & Willoughby, 2013; Sarsour et al., 2011). This association exists across the entire SES distribution, not simply among families living in poverty (Noble, McCandliss, & Farah, 2007). Previous research has not directly explored the association of food insecurity with EF.

EF difficulties have been consistently linked with externalizing psychopathology (Hatoum et al., 2017; Hobson, Scott, & Rubia, 2011). The association between low EF and higher externalizing psychopathology has been observed throughout development and across multiple domains of EF, including inhibition (Schoemaker, Mulder, Deković, & Matthys, 2013; Wang, Chassin, Lee, Haller, & King, 2017) and cognitive flexibility (Schoemaker et al., 2013; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). Lower BR has been linked to increased risk for externalizing disorders in cross-sectional and longitudinal studies (Eisenberg, Spinrad, & Eggum, 2010; Lonigan et al., 2017). Although the association between EF and internalizing disorders is less consistent, inhibitory control in response to emotional stimuli is one domain of EF that has been linked to greater internalizing disorders, such as depression (Capistrano et al., 2016; Joormann & Gotlib, 2010). Individuals experiencing depression may demonstrate difficulties inhibiting irrelevant or negative emotional stimuli (Goeleven, De Raedt, Baert, &), which may lead to emotional dysregulation, including rumination (Joormann, 2006; Joormann & Gotlib, 2010).

There is a dearth of existing research that has explored EF as a mediator between low SES and psychopathology in youth. One study most relevant to our hypothesis found that EF skills partially mediated the association between SES and aggression in youth (Fatima & Sheikh, 2014). To our knowledge, however, EF has not been explored as a mediator linking SES with other externalizing or internalizing psychopathology in children or adolescents.

We present a preliminary exploration of the hypothesis that difficulties in EF link SES with youth externalizing and internalizing psychopathology in two cross-sectional studies. We investigated to what degree two primary dimensions of EF (inhibitory control and cognitive flexibility), as well as the application of these skills in the service of BR, explain the association between multiple domains of SES and externalizing and internalizing psychopathology in two youth samples with wide variability in SES. These studies were designed to explore multiple components of SES separately, as opposed to as a composite measure. Previous literature has shown that SES composites do not necessarily capture, and may even obscure, substantial associations between SES and psychopathology (Call & Nonnemaker, 1999; Twenge & Nolen-Hoeksema, 2002). We also used multiple measures of EF to capture the diversity and complexity of EF-related processes (Friedman & Miyake, 2017). Previous research has demonstrated that task-based and self-report measures of EF capture complementary, yet distinct, components of cognitive control (Snyder, Friedman, & Hankin, 2020). We expected that children from lower-SES households would have higher externalizing and internalizing symptoms and worse EF performance. Finally, we anticipated that variation in EF would mediate the relationship between SES and externalizing psychopathology in children and adolescents. Because low SES often co-occurs with other forms of adversity, such as physical and sexual abuse, domestic violence, and other types of violence exposure (McLaughlin, Greif Green et al., 2012), it is important to determine whether SES-related variation in EF persists after controlling for exposure to violence (McLaughlin & Sheridan, 2016). Therefore, we additionally evaluated whether associations of SES persisted after adjusting for exposure to violence.

1. Study 1

1.1. Method

1.1.1. Sample

The sample for Study 1 included 94 children and adolescents (51.1% male) aged 6–18 years (M = 13.57, SD = 3.47). Participants described themselves as White (51.1%), Black (17%), Hispanic (13.8%), Asian (10.6%), and Other (7.4%). Youths were recruited for

participation at schools, after-school and prevention programs, medical clinics, and the general community between February 2014 and February 2015. Recruitment efforts were targeted at recruiting a sample with variation in exposure to adversity. To do so, we recruited from neighborhoods with high levels of violent crime, from clinics that served a predominantly low-SES catchment area, and agencies that work with families who have been victims of violence to identify children with exposure to trauma, as well as a variety of sources in the general community (e.g., public transportation, libraries, after-school programs, coffee shops, etc.) to identify children without adversity experiences. Approximately half of children in the final sample had experienced some form of adversity and the other half were control participants, matched on age and sex to those with adversity experiences. See Table 1 for socio-demographic characteristics. The Institutional Review Board (IRB) approved all procedures. Informed consent was obtained from all participants in the study.

1.1.2. Measures

Socioeconomic status (SES). A parent or guardian completed an SES questionnaire. Parent education was coded as the highest educational attainment of any parent. Income-to-needs ratio (INR) was calculated by dividing total household income by the 2014 U.S. census-defined poverty line for a family of that size, with a value less than one indicating that a family was living below the poverty line (e.g., $24,063 for a family of four) (U.S. Census Bureau, 2014). Being below the poverty line was a separate variable in order to isolate the lowest end of the income distribution. Food insecurity was used as a marker of more severe material deprivation, consistent with prior work on SES and child mental health (McLaughlin, Green, et al., 2012). Food insecurity in the past 12 months was assessed using items drawn from the short form of the U.S. Department of Agriculture's Food Security Scale, a validated measure of food insecurity that has been used in epidemiological surveys of youth psychopathology (McLaughlin, Green, et al., 2012). See Appendix A for a description of the items and Table 1 for descriptive statistics of SES.

Psychopathology. Internalizing and externalizing psychopathology were assessed using the Youth Self Report (YSR) form and the Child Behavioral Checklist (CBCL) (Achenbach, 1991; Rescorla & Achenbach, 2001). The internalizing and externalizing scales have demonstrated validity in discriminating between youths with and without psychiatric disorders (Achenbach, 1991; Chen, Faraone, Biederman, & Tsuang, 1994; Kendall et al., 2007). We examined symptoms based on the higher score between the child and parent reported psychopathology in order to capture unique information contributed by both reporters (Cantwell, Lewinsohn, Rohde, & Seeley, 1997). See Table 1 for descriptive statistics on psychopathology.

Parent Report of Executive Functioning. Parent ratings of EF in Study 1 were measured using the Behavior Rating Inventory of Executive Function (BRIEF) – Parent Form (Gioia, Isquith, Guy, & Kenworthy, 2000). This 86-item questionnaire asks parents to rate their child on everyday behavioral examples of EF. Here, we focus on BR, an EF domain that was not captured well in our behavioral task. The Behavioral Regulation Index (BRI) is a composite of the subdomains inhibition, shifting, and emotional control, and is reported as a total sum score, with a higher score indicating more difficulty with BR. As a measurement of executive functioning, the BRIEF is psychometrically sound with a high test-retest reliability ($r = 0.81$) during a two-week period, excellent convergent validity with other behavioral indications of EF (McCandless & O' Laughlin, 2007), and strong discriminant validity when used to assess children with and without clinically significant EF difficulties (e.g., in ADHD) (Gioia, Isquith, Retzlaff, & Espy, 2002; Reddy, Hale, & Brodzinsky, 2011).

Executive Functioning - Arrows Inhibition Task. Two components of executive functioning—inhibition and cognitive flexibility—were measured through the Arrows Inhibition Test (Arrows Task; Brooks, Sherman, & Strauss, 2010), which is composed of three timed trials: baseline, inhibition, and switching. See Appendix A for a description of each trial. Inhibitory control and switching ability were represented by difference in response time on each block relative to baseline. Smaller differences indicated better performance on inhibitory and switching trials. The inhibition trial of the Arrows Task has a test-retest reliability of 0.79 (ages 5–6), 0.81 (ages 7–8), 0.66 (ages 9–10), 0.80 (ages 11–12), and 0.82 (ages 13–16). The rule-switching trial has a test-retest reliability of 0.82 (ages 7–8), 0.78 (ages 9–10), 0.75 (ages 11–12), and 0.93 (ages 13–16) (Brooks et al., 2010). Test-retest intervals averaged 21 days (range 12–51 days). See Table 1 for descriptive statistics of the EF measures.

Table 1
Descriptive statistics of SES, violence exposure, executive function, and internalizing and externalizing psychopathology.

	Mean		SD		Range	
	Study 1[a]	**Study 2**[b]	**Study 1**	**Study 2**	**Study 1**	**Study 2**
Age	13.57	12.6	3.47	2.59	6.54–19.04	8.00–16.95
Income-to-needs Ratio	3.03	3.26	2.70	2.69	.13–8.33	.09–10.35
Food Insecurity	1.89	.99	2.23	1.66	.00–7.00	.00–6
BRIEF Behavioral Regulation Index	20.00	–	13.60	–	.00–50.00	–
Violence Exposure	0	5.12	1.52	3.61	-.89 – 6.36	.00–14.00
Arrows: Baseline Time (seconds)	24.96	17.94	10.15	4.54	8.00–52.18	10.00–32.47
Arrows: Inhibitory Control (seconds)	11.35	9.12	9.74	6.41	−1.05 – 66.81	−3.88 – 39.7
Arrows: Switching Ability (seconds)	17.29	11.88	11.5	6.39	3.21–62.43	−22.48 – 40.35
Emotional Stroop (milliseconds)	–	60.62	–	81.72	–	−238.7 – 754
Internalizing Symptoms (T-score)	58.23	60	10.47	10.76	38–87	33–87
Externalizing Symptoms (T-score)	55.95	56.65	10.33	10.79	34–83	33–81

[a] Study 1 n = 94.
[b] Study 2 n = 259.

Violence Exposure. Violence exposure was operationalized as exposure to child physical abuse, sexual abuse, or community violence, following prior work in this sample (Lambert, King, Monahan, & McLaughlin, 2017a). Physical and sexual abuse were measured through the Child Trauma Questionnaire (CTQ), which has demonstrated high internal consistency, test-retest reliability over a two-to six-month interval, and convergent and discriminant validity with other measures (Bernstein et al., 1997, 2003). The CTQ physical abuse and sexual abuse scales demonstrated high reliability within this sample ($\alpha = 0.82$ and $\alpha = 0.95$, respectively) and were summed to create a child abuse score. Exposure to community violence was measured through the Screen for Adolescent Violence Exposure (SAVE), which has demonstrated high internal consistency, test-retest reliability after a two-week interval, and convergent and discriminant validity with local crime data (Hastings & Kelley, 1997). The SAVE demonstrated high reliability within this sample ($\alpha = 0.82$). A community violence score was calculated by the sum of 12 items assessing direct exposure to community violence (e.g., being mugged or seeing someone get shot). A total violence exposure score was calculated as the sum of the standardized scores of the CTQ child abuse score and the SAVE community violence score (Lambert, King, Monahan, & McLaughlin, 2017b).

1.1.3. Statistical methods

Using linear regression, we first tested the association of each of the four measures of SES with internalizing and externalizing psychopathology separately ('a' path), for a total of eight models. Second, we tested the association of each measure of SES with the three measures of EF separately ('b' path) for a total of twelve models. Third, we tested each measure of EF with internalizing and externalizing psychopathology separately ('c' path) for a total of six models. Age and sex were included as covariates in all models. Age and sex did not moderate the associations of SES with EF or EF with psychopathology. Tests of indirect effects of SES on psychopathology through EF were conducted for each model listed above in which significant direct effects were observed for each of the three paths. Indirect effects were estimated using a non-parametric bootstrapping approach. Bootstrapped confidence intervals were calculated at 95 percent with 1000 bootstrap samples. Bootstrapping was only performed for the mediation models. This method is recommended when testing indirect effects, which are often non-normal in distribution and thus, violate the assumptions of conventional, parametric, regression tests. The linear regression models testing the direct effects did not violate this assumption, so a standard significance test was appropriate in those cases. All modeling was performed in R v3.5.1 (R Core Team, 2018) using the package 'lavaan' (v0.6.3 (Rosseel, 2012)). Full information maximum likelihood estimation was used to account for missing data in all models. To determine whether these associations persisted after adjusting for exposure to violence, we conducted a sensitivity analysis controlling for violence exposure in all models.

1.2. Results

1.2.1. SES and psychopathology

Demographic characteristics of the sample, along with the distribution of SES, EF, and psychopathology variables are presented in Table 1, and bivariate correlations are presented in Table 2. In Study 1, lower SES was associated with higher internalizing symptoms

Table 2
Zero-order correlations among socioeconomic status, violence exposure, executive functioning and internalizing and externalizing psychopathology variables.

Study 1										
	1	2	3	4	5	6	7	8	9	10
1. 1. Highest Parental Education	–									
1. 2. Income-to-needs Ratio	.68**	–								
1. 3. Food Insecurity	-.52**	-.62**	–							
1. 4. Below the Poverty Line	-.53**	-.71**	.64**	–						
1. 5. BRIEF Behavioral Regulation Index	-.28*	-.26*	.33**	.10	–					
1. 6. Arrows: Inhibitory Control	-.25*	-.11	.07	.06	.17	–				
1. 7. Arrows: Switching Ability	-.27*	-.23*	.23*	.14	.19	.42**	–			
1. 8. Internalizing Symptoms	-.31**	-.31**	.28**	.18	.52**	.05	.12	–		
1. 9. Externalizing Symptoms	-.18	-.34**	.28**	.21	.55**	.15	.07	.63**	–	
1. 10. Violence Exposure	−0.12	−0.12	0.15	.06	0.09	0.05	−0.14	.29**	.30**	–
Study 2										
	1	2	3	4	5	6	7	8	9	10
2. 1. Highest Parental Education	–									
2. 2. Income-to-needs Ratio	.56**	–								
2. 3. Food Insecurity	-.33**	-.50**	–							
2. 4. Below the Poverty Line	-.39**	-.64**	.51**	–						
2. 5. Arrows: Inhibitory Control	-.22*	-.24**	.26**	.35**	–					
2. 6. Arrows: Switching Ability	-.069	-.04	.11	.18*	.46**	–				
2. 7. Internalizing Symptoms	-.16*	-.22**	.34**	.17**	.16*	.09	–			
2. 8. Externalizing Symptoms	-.26**	-.29**	.37**	.22**	.31**	.25**	.67**	–		
2. 9. Emotional Stroop	.05	.16*	-.06	-.17**	-.06	-.02	.01	-.003	–	
2. 10. Violence Exposure	-.37**	-.44**	.32**	.27**	.18*	0.01	.46**	.52**	0.06	–

*p ≤ 0.05, **p ≤ 0.01.

across multiple measures of SES, including parent education, INR, and food insecurity. Lower INR and higher food insecurity, but not parent educational, were associated with higher externalizing symptoms (Table 3). After controlling for violence exposure, these associations persisted for income and parent education (Appendix Table A1).

1.2.2. SES and executive functioning

As shown in Table 4, lower SES was generally associated with difficulties with EF. Lower INR was associated with slower switching ability (i.e., higher response times on the Arrows Switching task) and lower BR (i.e., higher scores on the BRIEF BRI). Lower parent education was associated with lower inhibition (i.e. higher response time on the Arrows Task), slower switching ability, and lower BR. Higher food insecurity was associated with lower BR, but not other EF measures (Tables 4a and 4b). These findings remained after controlling for violence exposure (Appendix Tables A.2a and A.2b).

1.2.3. Executive functioning and psychopathology

Lower BR was associated with higher externalizing and internalizing symptoms (Table 5). No associations were observed between either inhibition or switching ability and psychopathology. This association between BR and higher psychopathology remained after controlling for violence exposure (Appendix Table A3).

1.2.4. Indirect effects of SES on psychopathology through EF

Tests of indirect effects were carried out when each of the three paths tested above was statistically significant (see Table 6 for indirect effects). Lower BR mediated the relationship between SES and internalizing and externalizing psychopathology. Lower BR accounted for 40% of the total effect of INR on internalizing symptoms (total b = −0.30, 95% CI [-0.51, −0.09]), 61% of the total effect of food insecurity on internalizing (total b = 0.26, 95% CI [0.07, 0.47]). Further, lower BR accounted for 36% of the total effect of INR on externalizing symptoms (total b = −0.33, 95% CI [-0.53, −0.16] and 63% of the total effect of food insecurity on externalizing symptoms (total b = 0.27, 95% CI [0.02, 0.49]).

When controlling for violence exposure in the mediation analyses, BR accounted for 41% of the total effect of INR on internalizing (total b = −0.26, 95% CI [-0.48, −0.07]; Appendix Table A.4) and 43% of the total effect of parent education on internalizing (total b = −0.25, 95% CI [-0.44, −0.06]). Lower BR accounted for 38% of the effect of INR on externalizing (total b = −0.29, 95% CI [-0.49, −0.12]). BR also continued to have an indirect effect on food insecurity and internalizing symptoms (b = 0.14, 95% CI [0.05, 0.26]) and externalizing symptoms (b = 0.15, 95% CI [0.05, 0.29]).

1.3. Discussion

In Study 1, we observed that lower SES was associated with lower EF performance across multiple domains, and higher internalizing and externalizing symptoms. This effect largely remained after controlling for violence exposure. Lower BR was associated with higher externalizing and internalizing symptoms, and partially mediated the association of low SES with higher psychopathology.

2. Study 2

2.1. Method

2.1.1. Sample

The sample for Study 2 included 259 children and adolescents (54.1% male) aged 8–16 years (M = 12.6, SD = 2.59, Table 1). Participants described themselves as White (39%), Black (29.3%), Latino (11.2%), Asian (10.8%), and Other (9.7%). Youths were recruited for participation at schools, after-school and prevention programs, medical clinics, and the general community between January 2015 and June 2017. Recruitment efforts were targeted at recruiting a sample with variation in exposure to adversity. To do so, we recruited from neighborhoods with high levels of violent crime, from clinics that served a predominantly low-SES catchment area, and agencies that work with families who have been victims of violence to identify children with exposure to trauma, as well as a variety of sources in the general community (e.g., public transportation, libraries, after-school programs, coffee shops, etc.) to identify children without adversity experiences. Approximately half of children in the final sample had experienced some form of adversity and the other half were control participants, matched on age and sex to those with adversity experiences. Additional details on adversity

Table 3
Linear regression models for socioeconomic status and externalizing and internalizing psychopathology.

	Externalizing Symptoms						Internalizing Symptoms					
	Study 1			Study 2			Study 1			Study 2		
	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}
Income-to-needs Ratio	-.33*	-.53	-.13	-.30*	-.42	-.18	-.30*	-.50	-.10	-.23*	-.35	-.10
Highest Parent Education	-.16	-.36	.04	-.27*	-.40	-.14	-.29*	-.49	-.09	-.16*	-.30	-.03
Food Insecurity	.27*	.06	.48	.36*	.24	.47	.26*	.05	.46	.34*	.22	.45
Below the Poverty Line	.41	-.01	.84	.48*	.20	.76	.35	-.09	.78	.41*	.14	.69

Age and sex were included as covariates in all analyses; *95% confidence interval did not include 0.

Table 4a
Linear regression models for socioeconomic status and executive functioning in the arrows task.

	Arrows: Inhibitory Control						Arrows: Switching Ability					
	Study 1			Study 2			Study 1			Study 2		
	B	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}
Income-to-needs Ratio	−0.09	−0.29	.12	-.22*	−0.36	−0.08	−0.19*	-.37	-.01	-.04	−0.20	0.11
Highest Parent Education	−0.23*	-.42	-.03	-.20*	−0.37	−0.04	−0.24*	-.43	-.05	-.06	−0.22	0.11
Food Insecurity	0.02	-.19	.23	.26*	0.12	0.41	0.16	-.03	.35	.14	−0.02	0.29
Below the Poverty Line	.10	-.32	.51	.79*	0.45	1.13	.23	-.15	0.62	.40*	0.02	0.78

Age and sex were included as covariates in all analyses; *95% confidence interval did not include 0.

Table 4b
Linear regression models for socioeconomic status and executive functioning in the BRIEF behavioral regulation index and emotional stroop task.

	BRIEF Behavioral Regulation Index			Emotional Stroop		
	Study 1			Study 2		
	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}
Income-to-needs Ratio	−0.24*	-.45	-.03	.16*	0.03	0.28
Highest Parent Education	−0.24*	-.44	-.05	.06	−0.10	0.22
Food Insecurity	0.30*	.10	.49	-.07	−0.20	0.05
Below the Poverty Line	.21	-.23	.64	-.39*	−0.67	−0.11

Age and sex were included as covariates in all analyses; *95% confidence interval did not include 0.

Table 5
Linear regression models for executive functioning and externalizing and internalizing psychopathology.

	Externalizing Symptoms						Internalizing Symptoms					
	Study 1			Study 2			Study 1			Study 2		
	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}
Arrows: Inhibitory Control	.13	-.08	.33	.31*	.16	.47	.01	-.20	.22	.18*	.03	.34
Arrows: Switching Ability	.03	-.20	.25	.27*	.11	.42	.07	-.15	.29	.11	-.04	.27
BRIEF Behavioral Regulation Index	.59*	.41	.77	–	–	–	.55*	.37	.74	–	–	–
Emotional Stroop	–	–	–	-.007	-.13	.12	–	–	–	.002	-.12	.13

Age and sex were included as covariates in all analyses; *95% confidence interval did not include 0.

Table 6
Mediation models and 95% confidence intervals for indirect effects of socioeconomic status on psychopathology, mediated by executive functioning.

	Externalizing Symptoms 95% Confidence Interval						Internalizing Symptoms 95% Confidence Interval					
	Study 1[a]			**Study 2**[b]			**Study 1**[a]			**Study 2**[b]		
	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}	β	CI_{Lower}	CI_{Upper}
Income-to-needs Ratio	-.12[c]	-.26	-.003	-.05[c]	-.10	-.004	-.12[c]	-.28	-.01	-.02	-.06	.02
Highest Parent Education	–	–	–	-.05	-.11	.00	-.12	-.26	.00	-.03	-.08	.01
Food Insecurity	.17[c]	.06	.31	.05[c]	.003	.10	.16[c]	.06	.30	.02	-.02	.07
Family Below Poverty Line	–	–	–	.17[c]	.02	.31	–	–	–	.05	-.09	.20

Age and sex were included as covariates in all analyses.
[a] Study 1 Mediator: BRIEF Behavioral Regulation Index.
[b] Study 2 Mediator: Arrow: Inhibitory Control.
[c] 95% confidence interval did not include 0.

exposure in the sample are reported elsewhere (Jenness et al., 2020; Weissman et al., 2019, 2020). The Institutional Review Board (IRB) approved all procedures. Informed consent was obtained from all participants in the study.

2.1.2. Measures

The measurement of SES indices matched the approach in Study 1. EF inhibition and rule-switching ability were repeated as in Study 1 by conducting the Arrows Task. Internalizing and externalizing psychopathology were also measured as in Study 1 through the YSR and CBCL questionnaires.

Executive Functioning - Emotional Stroop Task. In addition to the Arrows Task, participants in Study 2 completed the emotional

Stroop task, which assesses inhibition of responses to emotional stimuli (Etkin, Prater, Hoeft, Menon, & Schatzberg, 2010). On each trial, participants were asked to categorize a facial expression as happy or scared, while ignoring a word (i.e., "Happy" or "Fear") overlaid on the facial expression. During congruent trials, the facial expression and word matched; during incongruent trials, the facial expression and word did not match. A larger difference between the mean reaction time in milliseconds of congruent and incongruent trials indicated worse inhibition.

Violence Exposure. Children completed interview and self-report measures assessing child abuse and violence exposure; caregivers completed several questionnaire measures assessing children's exposure to maltreatment and trauma. See Appendix A for further details on each measure. A composite reflecting violence exposure across multiple indicators was created based on prior work in this sample (Sumner, Colich, Uddin, Armstrong, & McLaughlin, 2019). The composite was calculated by summing the total number of experiences of violence endorsed by the child and/or caregiver, including physical abuse, sexual abuse, emotional abuse, domestic violence, and exposure to other forms of interpersonal violence. Values ranged from 0 to 14 ($M = 5.11$, $SD = 3.61$). The violence exposure composite items demonstrated high reliability within this sample ($\alpha = 0.80$).

2.1.3. Statistical methods

The statistical methods used in Study 2 were identical to those used in Study 1.

2.2. Results

2.2.1. SES and psychopathology

Demographic characteristics of the sample, along with the distribution of SES, EF, and psychopathology variables are presented in Table 1, and bivariate correlations in Table 2. Lower SES, including parent education, INR, food insecurity and poverty, was associated with higher internalizing and externalizing symptoms (Table 3). This association remained for food insecurity after controlling for violence exposure (Appendix Table A1).

2.2.2. SES and executive functioning

Lower SES was generally associated with lower EF. Low SES in all four SES indicators was associated with lower inhibitory control. Poverty was the only SES measure associated with lower switching ability. Lower INR and poverty were associated with lower performance on the emotional Stroop task (Tables 4a and 4b). These associations between both food insecurity and poverty and inhibitory control remained when controlling for exposure to violence, as did the associations between both INR and poverty and the emotional Stroop task (Appendix Tables A.2a and A.2b).

2.2.3. Executive functioning and psychopathology

Lower EF was generally associated with higher externalizing and internalizing symptoms. Lower inhibitory control and lower switching ability were associated with higher externalizing symptoms. Lower inhibitory control was associated with higher internalizing symptoms. No association was observed between performance on the emotional Stroop task and psychopathology (Table 5). When controlling for exposure to violence, these results remain for the associations between lower inhibitory control and switching ability and higher externalizing symptoms (Appendix Table A3).

2.2.4. Indirect effects of SES on psychopathology through EF

Lower inhibitory control mediated the association between lower SES and externalizing symptoms (Table 6). Lower inhibitory control accounted for 14% of the total effect of INR on externalizing (total $b = -0.36$, 95% CI [-0.50, −0.22]), 13% of the total effect of food insecurity on externalizing (total $b = 0.39$, 95% CI [0.25, 0.53]), and 20% of the total effect of being below the poverty line on externalizing symptoms (total $b = 0.82$, 95% CI [0.47, 1.17]).

When controlling for violence exposure, inhibition had an indirect effect on INR and externalizing symptoms ($b = -0.04$, 95% CI [-0.08, −0.001]; Appendix Table A.4) and poverty and externalizing symptoms ($b = 0.13$, 95% CI [0.01, 0.25]). The indirect effect of inhibition on food insecurity and externalizing was not significant ($b = 0.03$, 95% CI [-0.003, 0.07]).

2.3. Discussion

Similar to the findings in Study 1, we observed in Study 2 that lower SES was associated with lower inhibitory control and higher internalizing and externalizing symptoms. Lower inhibitory control partially accounted for the association of lower SES, specifically INR and poverty, with externalizing symptoms, above the effect of violence exposure.

2.4. Combined discussion

In two studies, we examined the associations between different indicators of SES, domains of EF, and externalizing and internalizing psychopathology. Results from both studies were broadly similar. Lower SES was associated with lower EF performance, and lower SES and EF were associated with higher levels of psychopathology. In both studies, measures of EF (i.e., BR and inhibitory control) partially mediated the effect of SES on externalizing and internalizing psychopathology, although these indirect effects were attenuated after controlling for violence exposure. Importantly, however, BR and inhibitory control continued to have an indirect effect on the association between monetary indices of SES (i.e., INR, poverty) and psychopathology in both studies after controlling for

exposure to violence.

Lower SES across all indices was associated with higher levels of both internalizing and externalizing psychopathology. This is consistent with prior research that shows psychopathology in youth is more common in children raised in low-SES households (Capistrano et al., 2016; McLaughlin, Costello, et al., 2012; McLoyd, 1998). The association between SES and psychopathology has been demonstrated across various measures of SES and many types of psychopathology (Brooks-Gunn & Duncan, 1997; Peverill et al., 2020; Slopen, Fitzmaurice, Williams, & Gilman, 2010).

Lower SES was also associated with lower EF. BR (Study 1) and inhibitory control (Study 2) were associated with three indices of SES: INR, parent education, and food insecurity. Lower parent education and lower INR were also associated with lower cognitive flexibility (Study 1). Additionally, lower INR was associated with lower inhibitory control in emotional contexts (Study 2). These SES-related disparities in EF are consistent with prior research (Farah et al., 2006; Noble et al., 2007), including a recent meta-analysis (Lawson et al., 2018). We extend this prior literature, which has largely ignored the potential impact of co-occurring forms of adversity on the association between SES and EF, by demonstrating that these associations persist even after adjusting for violence exposure. Our approach is consistent with conceptual models that argue for the importance of controlling for co-occurring exposures when evaluating the developmental consequences of childhood adversity (McLaughlin & Sheridan, 2016). In particular, increasing evidence suggests that different dimensions of childhood adversity have unique developmental consequences that are obscured in studies that examine different types of adversity independently without controlling for co-occurring experiences (McLaughlin, Sheridan, & Lambert, 2014; Sheridan & McLaughlin, 2014). Here, we demonstrate that associations of SES with EF are not explained by co-occurring exposure to violence.

What might explain the association between SES and EF? Although the mechanisms linking SES with EF remain an area of ongoing research, existing evidence suggests that differences in environmental enrichment and cognitive stimulation in early childhood plays a role in the association of SES and EF. Differences in the degree of enrichment and cognitive stimulation in early home and school environments have been shown to vary in relation to SES (Bradley & Corwyn, 2002; Crosnoe et al., 2010; Hackman, Gallop, Evans, & Farah, 2015). For example, differences in linguistic experiences, such as family language complexity and syntactical structure, have consistently been shown to vary with SES (Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Rowe, 2012) and may play a role in the development of EF (Noble et al., 2005; Sheridan, Sarsour, Jutte, D'Esposito, & Boyce, 2012; Rosen et al., 2018). Cognitive stimulation (e.g., caregiver involvement in learning) and enrichment activities (e.g., variety in experiences outside the home) during childhood have been shown to partially account for the association between SES and EF, within cross-sectional (Amso, Salhi, & Badre, 2018; Sarsour et al., 2011) and longitudinal studies (Hackman et al., 2015; Rosen et al., 2019). Further, an intervention targeting cognitive stimulation in the home environment demonstrated improvement in EF over time in early childhood (Yousafzai et al., 2016). Collectively, this research indicates that cognitive stimulation in the early environment may be an underlying mechanism explaining the link between SES and EF.

All three components of EF—inhibition, cognitive flexibility, and BR—were negatively associated with externalizing and internalizing psychopathology. Lower EF has been associated with higher levels of externalizing psychopathology fairly consistently (Hobson et al., 2011; Schoemaker et al., 2013), while internalizing psychopathology has primarily been associated with lower inhibitory control (Goeleven et al., 2006; Joormann, 2006). Low EF performance, particularly lower BR and inhibition, could represent a transdiagnostic risk for psychopathology in youth (Snyder, Friedman, & Hankin, 2019). Difficulty controlling one's attention and impulses might increase behaviors and emotional reactions to external stimuli without previous thought or planning, which is common in youth with externalizing symptoms such as aggression (Giancola, Moss, Martin, Kirisci, & Tarter, 1996; Waller, Hyde, Baskin-Sommers, & Olson, 2017), hyperactivity (Berlin & Bohlin, 2002), and impulsivity (Olson, Sameroff, Kerr, Lopez, & Wellman, 2005).

Prior research has demonstrated mixed support regarding the extent to which difficulties with inhibitory control over emotional stimuli in particular are associated with internalizing psychopathology (Capistrano et al., 2016; Jarcho et al., 2013; Joormann & Gotlib, 2010). Our studies found support for this hypothesis using measures of inhibitory control in relation to neutral stimuli (i.e., arrows). However, inhibitory control in an emotional context was unrelated to psychopathology in Study 2, which is consistent with previous research using this task in youth (Jarcho et al., 2013). In contrast, parent-reported BR was associated with both internalizing and externalizing problems in Study 1. Parent-reported EF skills might be a particularly ecologically valid measure of inhibition related to emotional situations in daily life. Low BR and inhibitory control may potentially contribute to internalizing symptoms through difficulty inhibiting one's attention and emotional response to irrelevant or negative stimuli (Capistrano et al., 2016). Future research might focus on determining which mechanisms uniquely link inhibitory control to internalizing psychopathology.

Our results suggest that certain domains of EF partially mediate the effect of low SES on psychopathology in youth, an effect that has been shown in other forms of early childhood adversity involving deprivation (e.g., institutionalization) (Tibu et al., 2016). The findings from Study 1 suggest that difficulty with BR may make it challenging for children to employ EF skills in order to adapt to their environment, which may lead to greater externalizing or internalizing symptoms. In Study 2, inhibitory control emerged as the most consistent mediator, partially accounting for the effect of three SES indices on externalizing symptoms. These findings suggest that low SES is associated with inhibitory control in ways that might increase externalizing, but not necessarily internalizing, symptoms.

Notably, BR and inhibitory control emerged as significant mediators of the association of food insecurity with psychopathology, suggesting that EF may play a role in linking severe forms of material deprivation to psychopathology, beyond the effects of violence exposure. Food insecurity is a relatively severe form of material deprivation and is uniquely associated with psychopathology in youth (McLaughlin, Green, et al., 2012; Slopen et al., 2010). Children's cognitive development may be particularly impacted by inconsistent access to food. Although food insecurity is common in the U.S. (McLaughlin, Green, et al., 2012), it remains an under-studied form of adversity. Some indirect effects were attenuated after controlling for violence exposure, which may indicate that other mechanisms

associated with violence (i.e., emotional reactivity, emotion dysregulation, social information processing) might play more of a role than EF (see McLaughlin & Lambert, 2017 for a review). Greater research is needed to disentangle the relative importance of these pathways across different forms of adversity in order to identify the most promising targets for early interventions.

Several limitations should be considered when interpreting these findings. Each of our two studies used a cross-sectional design and so cannot establish temporal relationships between the study variables. Without longitudinal data, we cannot disentangle the bidirectional relationship between EF and psychopathology to know whether differences in SES necessarily preceded differences in behavioral regulation or inhibitory control, which then preceded differences in externalizing and internalizing psychopathology. Indeed, mental disorders have been associated with compromised EF capacity, such as difficulty concentrating in depression and anxiety (Hallion, Steinman, & Kusmierski, 2018; Keller, Leikauf, Holt-Gosselin, Staveland, & Williams, 2019), which could influence performance on EF tasks. Further, symptoms of psychopathology can impact youth's behavior in ways that influence their parent's perception of their EF skills, potentially leading to variability in parent-reported EF ability. However, the temporal order posited herein is supported by previous longitudinal research that has found prospective associations between SES and EF (Hackman et al., 2015; Rosen et al., 2019) and EF and psychopathology (Lonigan et al., 2017; Olson et al., 2005). Taken together, our indirect effects should be interpreted with caution given the cross-sectional design. Longitudinal studies examining EF as a mediator in these associations are clearly needed. Second, EF is a multidimensional construct, and we did not measure all components of EF in this study (e.g., working memory). Inhibitory control was tested for associations with SES and psychopathology in both studies, but only tested as a mediator in Study 2, given that in Study 1, inhibitory control was not associated with psychopathology. The reasons for differences in the results across the samples are unknown, but most likely reflect subtle differences in sample composition across the two studies. Notably, effect sizes for the association of SES with EF varied considerably across samples in a recent meta-analysis (Lawson et al., 2018). Third, we cannot infer severity of clinical impairment or diagnoses from these data, as we utilized the internalizing and externalizing subscales as continuous variables, as opposed to categories of diagnoses or clinically significant thresholds. Lastly, it is worth noting the time since data collection took place; Study 1 was conducted six years ago, and Study 2 four years ago. Nevertheless, the behavioral tasks and self-report surveys used to measure core study constructs remain the gold standards in the field. Thus, the time that has elapsed since data collection was completed is unlikely to meaningfully impact the inferences.

Across two socioeconomically diverse studies, we demonstrate multiple links between childhood SES, EF performance, and psychopathology in youth. Notably, EF partially mediated the associations of food insecurity, INR, and both internalizing and externalizing psychopathology, along with poverty, INR, and externalizing psychopathology, beyond the effect of co-occurring violence exposure. Lower EF performance most consistently accounted for the association between relatively severe forms of material deprivation and youth psychopathology. Understanding how growing up in a low-SES household influences cognitive and emotional development in ways that may confer risk for psychopathology is critical for identifying targets for early intervention.

Funding

This work was supported by a Brain and Behavior Foundation NARSAD Young Investigator Grant, the National Institute of Mental Health (R01-MH103291), a Jacobs Foundation Early Career Research Fellowship, and a One Mind Rising Star Award to KAM.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Review Board and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.adolescence.2021.04.010.

References

Achenbach, T. M. (1991). *Integrative guide for the 1991 CBCL/4-18, ysr, and trf profiles (1st US-1st printing edition)*. Univ Vermont/Dept Psychiatry.

Amso, D., Salhi, C., & Badre, D. (2018). The relationship between cognitive enrichment and cognitive control: A systematic investigation of environmental influences on development through socioeconomic status. *Developmental Psychobiology*. https://doi.org/10.1002/dev.21794.

Berlin, L., & Bohlin, G. (2002). Response inhibition, hyperactivity, and conduct problems among preschool children. *Journal of Clinical Child and Adolescent Psychology, 31*(2), 242–251. https://doi.org/10.1207/153744202753604511.

Bernstein, D. P., Ahluvalia, T., Pogge, D., & Handelsman, L. (1997). Validity of the childhood trauma questionnaire in an adolescent psychiatric population. *Journal of the American Academy of Child & Adolescent Psychiatry, 36*(3), 340–348. https://doi.org/10.1097/00004583-199703000-00012.

Bernstein, D. P., Stein, J. A., Newcomb, M. D., Walker, E., Pogge, D., Ahluvalia, T., et al. (2003). Development and validation of a brief screening version of the Childhood Trauma Questionnaire. *Child Abuse & Neglect, 27*(2), 169–190. https://doi.org/10.1016/S0145-2134(02)00541-0.

Best, J. R., & Miller, P. H. (2010). A developmental perspective on executive function. *Child Development, 81*(6), 1641–1660. https://doi.org/10.1111/j.1467-8624.2010.01499.x.

Blair, C., & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Development and Psychopathology, 20*. https://doi.org/10.1017/S0954579408000436, 03.

Blair, C., & Raver, C. C. (2016). Poverty, stress, and brain development: New directions for prevention and intervention. *Academic Pediatrics, 16*(3), S30–S36.

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology, 53*(1), 371–399. https://doi.org/10.1146/annurev.psych.53.100901.135233.

Brooks-Gunn, J., & Duncan, G. J. (1997). The effects of poverty on children. *The Future of Children, 7*(2), 55–71. https://doi.org/10.2307/1602387.

Brooks, B. L., Sherman, E. M. S., & Strauss, E. (2010). NEPSY-II: A developmental neuropsychological assessment, second edition. *Child Neuropsychology, 16*(1), 80–101. https://doi.org/10.1080/09297040903146966.

Call, K. T., & Nonnemaker, J. (1999). Socioeconomic disparities in adolescent health: Contributing factors. *Annals of the New York Academy of Sciences, 896*(1), 352–355. https://doi.org/10.1111/j.1749-6632.1999.tb08139.x.

Cantwell, D. P., Lewinsohn, P. M., Rohde, P., & Seeley, J. R. (1997). Correspondence between adolescent report and parent report of psychiatric diagnostic data. *Journal of the American Academy of Child & Adolescent Psychiatry, 36*(5), 610–619. https://doi.org/10.1097/00004583-199705000-00011.

Capistrano, C. G., Bianco, H., & Kim, P. (2016). Poverty and internalizing symptoms: The indirect effect of middle childhood poverty on internalizing symptoms via an emotional response inhibition pathway. *Frontiers in Psychology, 7*. https://doi.org/10.3389/fpsyg.2016.01242.

Chen, W. J., Faraone, S. V., Biederman, J., & Tsuang, M. T. (1994). Diagnostic accuracy of the child behavior checklist scales for attention-deficit hyperactivity disorder: A receiver-operating characteristic analysis. *Journal of Consulting and Clinical Psychology, 62*(5), 1017–1025. https://doi.org/10.1037/0022-006X.62.5.1017.

Crosnoe, R., Leventhal, T., Wirth, R. J., Pierce, K. M., Pianta, R. C., & Nichd Early Child Care Research Network. (2010). Family socioeconomic status and consistent environmental stimulation in early childhood: SES and environmental stimulation. *Child Development, 81*(3), 972–987. https://doi.org/10.1111/j.1467-8624.2010.01446.x.

Duncan, G. J., Brooks-Gunn, J., & Klebanov, P. K. (1994). Economic deprivation and early childhood development. *Child Development, 65*(2), 296–318. https://doi.org/10.2307/1131385.

Eisenberg, N., Spinrad, T. L., & Eggum, N. D. (2010). Emotion-related self-regulation and its relation to children's maladjustment. *Annual Review of Clinical Psychology, 6*(1), 495–525. https://doi.org/10.1146/annurev.clinpsy.121208.131208.

Etkin, A., Prater, K. E., Hoeft, F., Menon, V., & Schatzberg, A. F. (2010). Failure of anterior cingulate activation and connectivity with the amygdala during implicit regulation of emotional processing in generalized anxiety disorder. *American Journal of Psychiatry, 167*(5), 545–554. https://doi.org/10.1176/appi.ajp.2009.09070931.

Evans, G. W., & Rosenbaum, J. (2008). Self-regulation and the income-achievement gap. *Early Childhood Research Quarterly, 23*(4), 504–514. https://doi.org/10.1016/j.ecresq.2008.07.002.

Farah, M. J., Shera, D. M., Savage, J. H., Betancourt, L., Giannetta, J. M., Brodsky, N. L., et al. (2006). Childhood poverty: Specific associations with neurocognitive development. *Brain Research, 1110*(1), 166–174. https://doi.org/10.1016/j.brainres.2006.06.072.

Fatima & Sheikh. (2014). Socioeconomic status and adolescent aggression: The role of executive functioning as a mediator. *American Journal of Psychology, 127*(4), 419. https://doi.org/10.5406/amerjpsyc.127.4.0419.

Friedman, N. P., & Miyake, A. (2017). Unity and diversity of executive functions: Individual differences as a window on cognitive structure. *Cortex. A Journal Devoted to the Study of the Nervous System and Behavior, 86*, 186–204. https://doi.org/10.1016/j.cortex.2016.04.023.

Giancola, P. R., Moss, H. B., Martin, C. S., Kirisci, L., & Tarter, R. E. (1996). Executive cognitive functioning predicts reactive aggression in boys at high risk for substance abuse: A prospective study. *Alcoholism: Clinical and Experimental Research, 20*(4), 740–744. https://doi.org/10.1111/j.1530-0277.1996.tb01680.x.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). Test Review: Behavior rating inventory of executive function. *Child Neuropsychology, 6*(3), 235–238. https://doi.org/10.1076/chin.6.3.235.3152.

Gioia, G. A., Isquith, P. K., Retzlaff, P. D., & Espy, K. A. (2002). Confirmatory factor analysis of the behavior rating inventory of executive function (BRIEF) in a clinical sample. *Child Neuropsychology, 8*(4), 249–257. https://doi.org/10.1076/chin.8.4.249.13513.

Goeleven, E., De Raedt, R., Baert, S., & Koster, E. H. W. (2006). Deficient inhibition of emotional information in depression. *Journal of Affective Disorders, 93*(1–3), 149–157. https://doi.org/10.1016/j.jad.2006.03.007.

Hackman, D. A., Gallop, R., Evans, G. W., & Farah, M. J. (2015). Socioeconomic status and executive function: Developmental trajectories and mediation. *Developmental Science, 18*(5), 686–702. https://doi.org/10.1111/desc.12246.

Hallion, L. S., Steinman, S. A., & Kusmierski, S. N. (2018). Difficulty concentrating in generalized anxiety disorder: An evaluation of incremental utility and relationship to worry. *Journal of Anxiety Disorders, 53*, 39–45. https://doi.org/10.1016/j.janxdis.2017.10.007.

Hastings, T. L., & Kelley, M. L. (1997). Development and validation of the screen for adolescent violence exposure (SAVE). *Journal of Abnormal Child Psychology, 25*(6), 511–520. https://doi.org/10.1023/A:1022641916705.

Hatoum, A. S., Rhee, S. H., Corley, R. P., Hewitt, J. K., & Friedman, N. P. (2017). Do executive functions explain the covariance between internalizing and externalizing behaviors? *Development And Psychopathology*. https://doi.org/10.1017/S0954579417001602.

Hobson, C. W., Scott, S., & Rubia, K. (2011). Investigation of cool and hot executive function in ODD/CD independently of ADHD. *Journal of Child Psychology and Psychiatry, 52*(10), 1035–1043. https://doi.org/10.1111/j.1469-7610.2011.02454.x.

Huttenlocher, J., Waterfall, H., Vasilyeva, M., Vevea, J., & Hedges, L. V. (2010). Sources of variability in children's language growth. *Cognitive Psychology, 61*(4), 343–365. https://doi.org/10.1016/j.cogpsych.2010.08.002.

Jarcho, J. M., Fox, N. A., Pine, D. S., Etkin, A., Leibenluft, E., Shechner, T., et al. (2013). The neural correlates of emotion-based cognitive control in adults with early childhood behavioral inhibition. *Biological Psychology, 92*(2), 306–314. https://doi.org/10.1016/j.biopsycho.2012.09.008.

Jenness, J. L., Peverill, M., Miller, A. B., Heleniak, C., Robertson, M. M., Sambrook, K. A., et al. (2020). Alterations in neural circuits underlying emotion regulation following child maltreatment: A mechanism underlying trauma-related psychopathology. *Psychological Medicine*, 1–10. https://doi.org/10.1017/S0033291720000641.

Joormann, J. (2006). Differential effects of rumination and dysphoria on the inhibition of irrelevant emotional material: Evidence from a negative priming task. *Cognitive Therapy and Research, 30*(2), 149–160. https://doi.org/10.1007/s10608-006-9035-8.

Joormann, J., & Gotlib, I. H. (2010). Emotion regulation in depression: Relation to cognitive inhibition. *Cognition & Emotion, 24*(2), 281–298. https://doi.org/10.1080/02699930903407948.

Keller, A. S., Leikauf, J. E., Holt-Gosselin, B., Staveland, B. R., & Williams, L. M. (2019). Paying attention to attention in depression. *Translational Psychiatry, 9*(1), 1–12. https://doi.org/10.1038/s41398-019-0616-1.

Kendall, P. C., Puliafico, A. C., Barmish, A. J., Choudhury, M. S., Henin, A., & Treadwell, K. S. (2007). Assessing anxiety with the child behavior checklist and the teacher report form. *Journal of Anxiety Disorders, 21*(8), 1004–1015. https://doi.org/10.1016/j.janxdis.2006.10.012.

Lambert, H. K., King, K. M., Monahan, K. C., & McLaughlin, K. A. (2017a). Differential associations of threat and deprivation with emotion regulation and cognitive control in adolescence. *Development and Psychopathology, 29*(3), 929–940. https://doi.org/10.1017/S0954579416000584.

Lambert, H. K., King, K. M., Monahan, K. C., & McLaughlin, K. A. (2017b). Differential associations of threat and deprivation with emotion regulation and cognitive control in adolescence. *Development and Psychopathology, 29*, 929–940. https://doi.org/10.1017/S0954579416000584, 03.

Lawson, G. M., Hook, C. J., & Farah, M. J. (2018). A meta-analysis of the relationship between socioeconomic status and executive function performance among children. *Developmental Science, 21*(2), Article e12529. https://doi.org/10.1111/desc.12529.

Lonigan, C. J., Spiegel, J. A., Goodrich, J. M., Morris, B. M., Osborne, C. M., Lerner, M. D., et al. (2017). Does preschool self-regulation predict later behavior problems in general or specific problem behaviors? *Journal of Abnormal Child Psychology, 45*(8), 1491–1502. https://doi.org/10.1007/s10802-016-0260-7.

McCandless, S., & O' Laughlin, L. (2007). The clinical utility of the behavior rating inventory of executive function (BRIEF) in the diagnosis of ADHD. *Journal of Attention Disorders, 10*(4), 381–389. https://doi.org/10.1177/1087054706292115.

McLaughlin, K. A. (2016). Future directions in childhood adversity and youth psychopathology. *Journal of Clinical Child and Adolescent Psychology, 45*(3), 361–382. https://doi.org/10.1080/15374416.2015.1110823.

McLaughlin, K. A., Costello, E. J., Leblanc, W., Sampson, N. A., & Kessler, R. C. (2012). Socioeconomic status and adolescent mental disorders. *American Journal of Public Health, 102*(9), 1742–1750. https://doi.org/10.2105/AJPH.2011.300477.

McLaughlin, K. A., Green, J. G., Alegría, M., Costello, E. J., Gruber, M. J., Sampson, N. A., et al. (2012). Food insecurity and mental disorders in a national sample of U. S. Adolescents. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*(12), 1293–1303. https://doi.org/10.1016/j.jaac.2012.09.009.

McLaughlin, K. A., Greif Green, J., Gruber, M. J., Sampson, N. A., Zaslavsky, A. M., & Kessler, R. C. (2012). Childhood adversities and first onset of psychiatric disorders in a national sample of US adolescents. *Archives of General Psychiatry, 69*(11), 1151. https://doi.org/10.1001/archgenpsychiatry.2011.2277.

McLaughlin, K. A., & Sheridan, M. A. (2016). Beyond cumulative risk: A dimensional approach to childhood adversity. *Current Directions in Psychological Science, 25*(4), 239–245. https://doi.org/10.1177/0963721416655883.

McLaughlin, K. A., Sheridan, M. A., & Lambert, H. K. (2014). Childhood adversity and neural development: Deprivation and threat as distinct dimensions of early experience. *Neuroscience and Biobehavioral Reviews, 47*, 578–591. https://doi.org/10.1016/j.neubiorev.2014.10.012.

McLoyd, V. C. (1998). Socioeconomic disadvantage and child development. *American Psychologist, 53*(2), 185–204. https://doi.org/10.1037/0003-066X.53.2.185.

Miller, P., Votruba-Drzal, E., & Setodji, C. M. (2013). Family income and early achievement across the urban–rural continuum. *Developmental Psychology, 49*(8), 1452–1465. https://doi.org/10.1037/a0030244.

Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science, 21*(1), 8–14. https://doi.org/10.1177/0963721411429458.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734.

Noble, K. G., Farah, M. J., & McCandliss, B. D. (2006). Socioeconomic background modulates cognition–achievement relationships in reading. *Cognitive Development, 21*(3), 349–368. https://doi.org/10.1016/j.cogdev.2006.01.007.

Noble, K. G., McCandliss, B. D., & Farah, M. J. (2007). Socioeconomic gradients predict individual differences in neurocognitive abilities. *Developmental Science, 10*(4), 464–480. https://doi.org/10.1111/j.1467-7687.2007.00600.x.

Noble, K. G., Norman, M. F., & Farah, M. J. (2005). Neurocognitive correlates of socioeconomic status in kindergarten children. *Developmental Science, 8*(1), 74–87. https://doi.org/10.1111/j.1467-7687.2005.00394.x.

Olson, S. L., Sameroff, A. J., Kerr, D. C. R., Lopez, N. L., & Wellman, H. M. (2005). Developmental foundations of externalizing problems in young children: The role of effortful control. *Development and Psychopathology, 17*(1), 25–45. https://doi.org/10.1017/S0954579405050029.

Peverill, M., Dirks, M. A., Narvaja, T., Herts, K. L., Comer, J. S., & McLaughlin, K. A. (2020). Socioeconomic status and child psychopathology in the United States: A meta-analysis of population-based studies. *Clinical Psychology Review*, 101933. https://doi.org/10.1016/j.cpr.2020.101933.

R Core Team. (2018). *R: A Language and Environment for statistical computing. R: The R foundation for statistical computing*. https://www.r-project.org/.

Raver, C. C., Blair, C., & Willoughby, M. (2013). Poverty as a predictor of 4-year-olds' executive function: New perspectives on models of differential susceptibility. *Developmental Psychology, 49*(2), 292–304. https://doi.org/10.1037/a0028343.

Reddy, L. A., Hale, J. B., & Brodzinsky, L. K. (2011). Discriminant validity of the behavior rating inventory of executive function parent form for children with attention-deficit/hyperactivity disorder. *School Psychology Quarterly, 26*(1), 45–55. https://doi.org/10.1037/a0022585.

Rescorla, L. A., & Achenbach, T. M. (2001). Manual for the ASEBA school-age forms & profiles. *ASEBA*.

Rosen, M. L., Hagen, M. P., Lurie, L. A., Miles, Z. E., Sheridan, M. A., Meltzoff, A. N., et al. (2019). Cognitive stimulation as a mechanism linking socioeconomic status with executive function: A longitudinal investigation. *Child Development*, 1–18. https://doi.org/10.1111/cdev.13315, 00(0).

Rosen, M. L., Sheridan, M. A., Sambrook, K. A., Meltzoff, A. N., & McLaughlin, K. A. (2018). Socioeconomic disparities in academic achievement: A multi-modal investigation of neural mechanisms in children and adolescents. *NeuroImage, 173*, 298–310. https://doi.org/10.1016/j.neuroimage.2018.02.043.

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software, 48*(1), 1–36. https://doi.org/10.18637/jss.v048.i02.

Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development: Child-directed speech and vocabulary. *Child Development, 83*(5), 1762–1774. https://doi.org/10.1111/j.1467-8624.2012.01805.x.

Samuels, W. E., Tournaki, N., Blackman, S., & Zilinski, C. (2016). Executive functioning predicts academic achievement in middle school: A four-year longitudinal study. *The Journal of Educational Research, 109*(5), 478–490. https://doi.org/10.1080/00220671.2014.979913.

Sarsour, K., Sheridan, M., Jutte, D., Nuru-Jeter, A., Hinshaw, S., & Boyce, W. T. (2011). Family socioeconomic status and child executive functions: The roles of language, home environment, and single parenthood. *Journal of the International Neuropsychological Society, 17*(1), 120–132. https://doi.org/10.1017/S1355617710001335.

Schoemaker, K., Mulder, H., Deković, M., & Matthys, W. (2013). Executive functions in preschool children with externalizing behavior problems: A meta-analysis. *Journal of Abnormal Child Psychology, 41*(3), 457–471. https://doi.org/10.1007/s10802-012-9684-x.

Semega, J., Kollar, M., Creamer, J., & Mohanty, A. (2019). *Income and Poverty in the United States: 2018 (No. P60-266; current population reports* (p. 88). U.S. Census Bureau. https://www.census.gov/content/dam/Census/library/publications/2019/demo/p60-266.pdf.

Shankar, P., Chung, R., & Frank, D. A. (2017). Association of food insecurity with children's behavioral, emotional, and academic outcomes: A systematic Review. *Behavioral Pediatrics, 38*(2), 16.

Sheridan, M. A., Sarsour, K., Jutte, D., D'Esposito, M., & Boyce, W. T. (2012). The impact of social disparity on prefrontal function in childhood. *PloS One, 7*(4), Article e35744. https://doi.org/10.1371/journal.pone.0035744.

Sheridan, M. A., & McLaughlin, K. A. (2014). Dimensions of early experience and neural development: Deprivation and threat. *Trends in Cognitive Sciences, 18*(11), 580–585. https://doi.org/10.1016/j.tics.2014.09.001.

Slopen, N., Fitzmaurice, G., Williams, D. R., & Gilman, S. E. (2010). Poverty, food insecurity, and the behavior for childhood internalizing and externalizing disorders. *Journal of the American Academy of Child & Adolescent Psychiatry, 49*(5), 444–452. https://doi.org/10.1097/00004583-201005000-00005.

Snyder, H. R., Friedman, N. P., & Hankin, B. L. (2019). *Transdiagnostic mechanisms of psychopathology in youth: Executive functions, dependent stress, and rumination. Cognitive Therapy and research*. https://doi.org/10.1007/s10608-019-10016-z.

Snyder, H. R., Friedman, N. P., & Hankin, B. L. (2020). Associations between task performance and self-report measures of cognitive control: Shared versus distinct abilities. *Assessment*. https://doi.org/10.1177/1073191120965694, 1073191120965694.

Sumner, J. A., Colich, N. L., Uddin, M., Armstrong, D., & McLaughlin, K. A. (2019). Early experiences of threat, but not deprivation, are associated with accelerated biological aging in children and adolescents. *Biological Psychiatry, 85*(3), 268–278. https://doi.org/10.1016/j.biopsych.2018.09.008.

Tibu, F., Sheridan, M. A., McLaughlin, K. A., Nelson, C. A., Fox, N. A., & Zeanah, C. H. (2016). Disruptions of working memory and inhibition mediate the association between exposure to institutionalization and symptoms of attention deficit hyperactivity disorder. *Psychological Medicine, 46*(3), 529–541. https://doi.org/10.1017/S0033291715002020.

Twenge, J. M., & Nolen-Hoeksema, S. (2002). Age, gender, race, socioeconomic status, and birth cohort difference on the children's depression inventory: A meta-analysis. *Journal of Abnormal Psychology*, 578–588.

U.S. Census Bureau. (2014). *Poverty thresholds by size of family and number of related children under 18 years*. https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html.

Waller, R., Hyde, L. W., Baskin-Sommers, A. R., & Olson, S. L. (2017). Interactions between callous unemotional behaviors and executive function in early childhood predict later aggression and lower peer-liking in late-childhood. *Journal of Abnormal Child Psychology, 45*(3), 597–609. https://doi.org/10.1007/s10802-016-0184-2.

Wang, F. L., Chassin, L., Lee, M., Haller, M., & King, K. (2017). Roles of response inhibition and gene–environment interplay in pathways to adolescents' externalizing problems. *Journal of Research on Adolescence, 27*(2), 258–277. https://doi.org/10.1111/jora.12270.

Weissman, D. G., Bitran, D., Miller, A. B., Schaefer, J. D., Sheridan, M. A., & McLaughlin, K. A. (2019). Difficulties with emotion regulation as a transdiagnostic mechanism linking child maltreatment with the emergence of psychopathology. *Development and Psychopathology, 31*(3), 899–915. https://doi.org/10.1017/S0954579419000348.

Weissman, D. G., Jenness, J. L., Colich, N. L., Miller, A. B., Sambrook, K. A., Sheridan, M. A., et al. (2020). Altered neural processing of threat-related information in children and adolescents exposed to violence: A transdiagnostic mechanism contributing to the emergence of psychopathology. *Journal of the American Academy of Child & Adolescent Psychiatry, 59*(11), 1274–1284. https://doi.org/10.1016/j.jaac.2019.08.471.

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: A meta-analytic Review. *Biological Psychiatry, 57*(11), 1336–1346. https://doi.org/10.1016/j.biopsych.2005.02.006.

Yousafzai, A. K., Obradović, J., Rasheed, M. A., Rizvi, A., Portilla, X. A., Tirado-Strayer, N., et al. (2016). Effects of responsive stimulation and nutrition interventions on children's development and growth at age 4 years in a disadvantaged population in Pakistan: A longitudinal follow-up of a cluster-randomised factorial effectiveness trial. *The Lancet Global Health, 4*(8), e548–e558. https://doi.org/10.1016/S2214-109X(16)30100-0.

Zelazo, P. D., & Mller, U. (2002). Executive function in typical and atypical development. In U. Goswami (Ed.), *Blackwell handbook of childhood cognitive development* (pp. 445–469). Blackwell Publishers Ltd. https://doi.org/10.1002/9780470996652.ch20.

Zhou, Q., Chen, S. H., & Main, A. (2012). Commonalities and differences in the research on children's effortful control and executive function: A call for an integrated model of self-regulation. *Child Development Perspectives, 6*(2), 112–121. https://doi.org/10.1111/j.1750-8606.2011.00176.x.